

WHAT IS CLAIMED IS:

1. Fly ash characterized by
  - a) substantially uniform spherical shape;
  - 5 b) greater than about 90% of the particles have a diameter of less than 11  $\mu\text{m}$ , greater than about 60% of the particles have a diameter of less than 5.5  $\mu\text{m}$ , and greater than about 15% of the particles have a diameter of less than 1.375  $\mu\text{m}$ ;
  - c) a median particle diameter of less than about 4.0  $\mu\text{m}$ ; and
  - d) a range of particle diameters of from about 0.1  $\mu\text{m}$  to about 70  $\mu\text{m}$ .
- 10 2. The fly ash of claim 1, wherein greater than about 93 % of the particles have a diameter of less than 11  $\mu\text{m}$ , greater than about 70% of the particles have a diameter of less than 5.5  $\mu\text{m}$ , and greater than about 18% of the particles have a diameter of less than 1.375  $\mu\text{m}$ .
- 15 3. The fly ash of claim 1, wherein the median particle diameter is less than about 3.0  $\mu\text{m}$ .
4. The fly ash of claim 1, wherein the range of particle diameters is from about 0.9  $\mu\text{m}$  to about 62  $\mu\text{m}$ .
- 20 5. The fly ash of claim 1, wherein
  - a) greater than about 93 % of the particles have a diameter of less than 11  $\mu\text{m}$ , greater than about 70% of the particles have a diameter of less than 5.5  $\mu\text{m}$ , and greater than about 18% of the particles have a diameter of less than 1.375  $\mu\text{m}$ ;
  - 25 b) the median particle diameter is less than about 3.0  $\mu\text{m}$ ; and
  - c) the range of particle diameters is from about 0.9  $\mu\text{m}$  to about 62  $\mu\text{m}$ .
6. The fly ash of claim 5, which is prepared by grinding unfractionated fly ash.
- 30 7. A concrete comprising about 1 part by weight cementitious materials, about 1 to about 3 parts by weight fine aggregate, about 1 to about 5 parts by weight coarse aggregate, and about 0.35 to about 0.6 parts by weight water, wherein the cementitious materials comprise from about 10% to about 50% by weight the fly ash of claim 1 and about 50% to about 90% by weight cement.

8. A concrete comprising about 1 part by weight cementitious materials, about 1 to about 3 parts by weight fine aggregate, about 1 to about 5 parts by weight coarse aggregate, and about 0.35 to about 0.6 parts by weight water, wherein the cementitious materials comprise from about 10% to about 50% by weight the fly ash of claim 5 and about 50% to about 90% by weight cement.
9. The concrete of claim 7 further comprising silica fume.
10. The concrete of claim 7 further comprising glass fibers.
11. A mortar comprising about 1 part by weight cementitious materials, about 1 to about 3 parts by weight fine aggregate, and about 0.35 to about 0.6 parts by weight water, wherein the cementitious materials comprise from about 10% to about 50% by weight the fly ash of claim 1 and about 50% to about 90% by weight cement.
12. A mortar comprising about 1 part by weight cementitious materials, about 1 to about 3 parts by weight fine aggregate, and about 0.35 to about 0.6 parts by weight water, wherein the cementitious materials comprise from about 10% to about 50% by weight the fly ash of claim 5 and about 50% to about 90% by weight cement.
13. The mortar of claim 12 further comprising silica fume.
14. The mortar of claim 12 further comprising glass fibers.
15. Fly ash prepared by processing fly ash so as to shift the size distribution to have the following characteristics:
- a) substantially uniform spherical shape; greater than about 90% of the particles have a diameter of less than 11  $\mu\text{m}$ , greater than about 60% of the particles have a diameter of less than 5.5  $\mu\text{m}$ , and greater than about 15% of the particles have a diameter of less than 1.375  $\mu\text{m}$ ;
  - c) a median particle diameter of less than about 4.0  $\mu\text{m}$ ; and
  - d) a range of particle diameters of from about 0.1  $\mu\text{m}$  to about 70  $\mu\text{m}$ .
16. The fly ash of claim 15 wherein the processing comprises grinding with a fluidized bed grinding process using a ratio of one part unfractionated fly ash with four parts grinding

media (by volume).

17. The fly ash of claim 16 wherein the grinding media is zirconium silicate.
- 5 18. The fly ash of claim 16 wherein the grinding media is carbon steel.
19. A concrete comprising about 1 part by weight cementitious materials, about 1 to about 3 parts by weight fine aggregate, about 1 to about 5 parts by weight coarse aggregate, and about 0.35 to about 0.6 parts by weight water, wherein the cementitious materials  
10 comprise from about 10% to about 50% by weight the fly ash of claim 15 and about 50% to about 90% by weight cement.
20. The concrete of Claim 19, further comprising silica fume.
- 15 21. The concrete of Claim 19, further comprising glass fibers.
22. A concrete comprising about 1 part by weight cementitious materials, about 1 to about 3 parts by weight fine aggregate, about 1 to about 5 parts by weight coarse aggregate, and about 0.35 to about 0.6 parts by weight water, wherein the cementitious materials  
20 comprise from about 10% to about 50% by weight the fly ash of claim 17 and about 50% to about 90% by weight cement.
23. The concrete of claim 22 further comprising silica fume.
- 25 24. The concrete of claim 22 further comprising glass fibers.
25. A mortar comprising about 1 part by weight cementitious materials, about 1 to about 3 parts by weight fine aggregate, and about 0.35 to about 0.6 parts by weight water, wherein the cementitious materials comprise from about 10% to about 50% by weight the  
30 fly ash of claim 15 and about 50% to about 90% by weight cement.
26. A mortar comprising about 1 part by weight cementitious materials, about 1 to about 3 parts by weight fine aggregate, and about 0.35 to about 0.6 parts by weight water, wherein the cementitious materials comprise from about 10% to about 50% by weight the  
35 fly ash of claim 17 and about 50% to about 90% by weight cement.

27. The mortar of claim 26 further comprising silica fume.
28. The mortar of claim 26 further comprising glass fibers.
- 5 29. A method for preparing fly ash comprising processing fly ash so as to shift the size distribution to have the following characteristics:
- a) substantially uniform spherical shape;
  - b) greater than about 90% of the particles have a diameter of less than 11  $\mu\text{m}$ , greater than about 60% of the particles have a diameter of less than 5.5  $\mu\text{m}$ , and greater than about 15% of the particles have a diameter of less than 1.375  $\mu\text{m}$ ;
  - c) a median particle diameter of less than about 4.0  $\mu\text{m}$ ; and
  - d) a range of particle diameters of from about 0.1  $\mu\text{m}$  to about 70  $\mu\text{m}$ .
- 10 30. The method according to claim 29 wherein the processing comprises grinding with a fluidized bed grinding process using a ratio of one part unfractionated fly ash with four parts grinding media (by volume).
31. The method according to claim 30, wherein the grinding media is zirconium silicate.
- 15 32. The method according to claim 30 wherein the grinding media is carbon steel.
33. The method according to claim 29 wherein the fly ash is dry bottom boiler fly ash.
34. The method according to claim 29 wherein the fly ash is wet bottom boiler fly ash.
- 25 35. Fly ash prepared by processing fly ash so as to shift the size distribution to have the following characteristics:
- a) substantially uniform spherical shape;
  - b) greater than about 90% of the particles have a diameter of less than 12  $\mu\text{m}$ , greater than about 50% of the particles have a diameter of less than 5  $\mu\text{m}$ , and greater than about 15% of the particles have a diameter of less than 2.3  $\mu\text{m}$ ;
  - c) a median particle diameter of less than about 6.0  $\mu\text{m}$ ; and
  - d) a range of particle diameters of from about 0.78  $\mu\text{m}$  to about 30  $\mu\text{m}$ .
- 30 36. The fly ash of claim 35, wherein the processing comprises grinding the fly ash with a
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grinding medium in a non-expanded bed, and the volume of fly ash is less than the void volume of the grinding medium.

37. The fly ash of Claim 36, wherein the ratio of fly ash to grinding medium is about 1 part fly ash to about 4 parts grinding medium, by volume.
38. The fly ash of Claim 36, wherein the ratio of fly ash to grinding medium is about 1 part fly ash to about 18 parts grinding medium, by weight.
39. The fly ash of claim 36 wherein the grinding media comprises carbon steel or stainless steel.
40. A concrete comprising about 1 part by weight cementitious materials, about 1 to about 3 parts by weight fine aggregate, about 1 to about 5 parts by weight coarse aggregate, and about 0.35 to about 0.6 parts by weight water, wherein the cementitious materials comprise from about 10% to about 50% by weight the fly ash of claim 35 and about 50% to about 90% by weight cement.
41. The concrete of Claim 40, further comprising silica fume, glass fibers, or a combination thereof.
42. A concrete comprising about 1 part by weight cementitious materials, about 1 to about 3 parts by weight fine aggregate, about 1 to about 5 parts by weight coarse aggregate, and about 0.35 to about 0.6 parts by weight water, wherein the cementitious materials comprise from about 10% to about 50% by weight the fly ash of claim 36 and about 50% to about 90% by weight cement.
43. The concrete of Claim 42, wherein the ratio of fly ash to grinding medium is about 1 part fly ash to about 4 parts grinding medium, by volume.
44. The concrete of Claim 42, wherein the ratio of fly ash to grinding medium is about 1 part fly ash to about 18 parts grinding medium, by weight.
45. The concrete of Claim 42, wherein the grinding medium comprises carbon steel.

46. The concrete of Claim 42, further comprising silica fume, glass fibers, or a combination thereof.
- 5 47. A mortar comprising about 1 part by weight cementitious materials, about 1 to about 3 parts by weight fine aggregate, and about 0.35 to about 0.6 parts by weight water, wherein the cementitious materials comprise from about 10% to about 50% by weight the fly ash of claim 35 and about 50% to about 90% by weight cement.
- 10 48. A mortar comprising about 1 part by weight cementitious materials, about 1 to about 3 parts by weight fine aggregate, and about 0.35 to about 0.6 parts by weight water, wherein the cementitious materials comprise from about 10% to about 50% by weight the fly ash of claim 36 and about 50% to about 90% by weight cement.
- 15 49. The mortar of Claim 48, wherein the ratio of fly ash to grinding medium is about 1 part fly ash to about 4 parts grinding medium by volume.
50. The mortar of Claim 48, wherein the ratio of fly ash to grinding medium is about 1 part fly ash to about 18 parts grinding medium, by weight.
- 20 51. The mortar of Claim 48, wherein the grinding medium is carbon steel.
52. The mortar of Claim 48, wherein the grinding medium is stainless steel.
- 25 53. The mortar of Claim 48, further comprising silica fume, glass fibers, or a combination thereof.
54. A method for preparing fly ash comprising processing fly ash so as to shift the size distribution to have the following characteristics:
- 30 a) substantially uniform spherical shape;
- b) greater than about 90% of the particles have a diameter of less than 12  $\mu\text{m}$ , greater than about 50% of the particles have a diameter of less than 5  $\mu\text{m}$ , and greater than about 15% of the particles have a diameter of less than 2.3  $\mu\text{m}$ ;
- c) a median particle diameter of less than about 6.0  $\mu\text{m}$ ; and
- 35 d) a range of particle diameters of from about 0.78  $\mu\text{m}$  to about 30  $\mu\text{m}$ .

55. The method of Claim 54, comprising grinding the fly ash with a grinding medium in a non-expanded bed, wherein the volume of fly ash is less than the void volume of the grinding medium.
- 5 56. The method of Claim 55, wherein the ratio of fly ash to grinding medium is about 1 part fly ash to about 4 parts grinding medium, by volume.
57. The method of Claim 55, wherein the ratio of fly ash to grinding medium is about 1 part fly ash to about 18 parts grinding medium, by weight.
- 10 58. The method of Claim 55, wherein the grinding medium comprises stainless steel.
59. The method of Claim 55, wherein the grinding medium comprises carbon steel.
- 15 60. The method of Claim 54, wherein the fly ash is dry bottom boiler fly ash.
61. The method of Claim 54, wherein the fly ash is wet bottom boiler fly ash.